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# EFFECTS OF AQUEOUS EXTRACTS OF COVER CROPS ON THE GERMINATION OF SEEDS OF BLACK AND WHITE SPRUCE

Report No 84-19-K

G.P. Arron
Biologist
Biological Research Section
Chemical Research Department

## ABSTRACT

Cover crops planted by Ontario Hydro on rights-of-way to establish a stable maintenance-free ground cover provide erosion control and resist the invasion of the right-of-way by undesirable species. The present study was conducted to determine if any of these cover crops have a direct adverse effect on the development of several woody species found on such rights-of-way. The effects of aqueous extracts prepared from shoot and root material of twenty cover crops and mixtures of cover crops, on the germination of black spruce (*Picea mariana* (Mill.) B.S.P.) and white spruce (*P. glauca* (Moench) Voss) seeds were determined. The extracts of the grasses tall fescue (*Festuca arundinacea* Schreb.), juno orchard-grass (*Dactylis glomerata* L.), Canada bluegrass (*Poa compressa* L.), Kentucky bluegrass (*P. pratensis* L.), climax timothy (*Phleum pratense* L.), and the legume white sweet clover (*Melilotus alba* Desr.) inhibited the germination of white spruce seeds, with the legume being particularly inhibitory. Extracts of the legumes crown-vetch (*Coronilla varia* L.), white clover (*Trifolium repens* L.) and white sweetclover were very effective in inhibiting the germination of black spruce seeds. Of the cover crops examined white sweetclover was the most effective inhibitor of germination of both black and white spruce seeds.



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To Mr. F.J. Kee
Director of Research

# EFFECTS OF AQUEOUS EXTRACTS OF COVER CROPS ON THE GERMINATION OF SEEDS OF BLACK AND WHITE SPRUCE

G.P. Arron

## 1.0 INTRODUCTION

Following construction on Ontario Hydro rights-of-way, cover crops are commonly planted in an attempt to establish a stable maintenance-free ground cover that will both provide erosion control and resist the invasion by incompatible or undesirable species. This use of cover crops complements the selective vegetation control program adopted by Ontario Hydro at present, and ultimately contributes to reduced maintenance costs. In most instances the cover crops in use are introduced species. Native species have been considered, but few meet the criteria for a successful cover crop, such as ease of establishment, tolerance of a range of site conditions, and persistence from year to year. Native species seed is also rarely available in commercial quantities.

The use of cover crops by Ontario Hydro has been documented recently (Ontario Hydro Hydraulic Generation and Transmission Division Report No 0055f12).

The allelopathic properties of some of the mixtures of cover crops used by Ontario Hydro are thought to provide some basis for the resistance to invasion of the area where the cover crops grow by other plant species. Nothing is known about the allelopathic properties of individual cover crops and the specific plant species which are inhibited by those cover crops. Allelopathy, the effect of one species of plant on the growth and development of another, has been reviewed recently (Ontario Hydro Research Division Report No 82-461-K).

In the following experiments, the effects of aqueous extracts prepared from the shoots and roots of eighteen cover crops used by Ontario Hydro, and two mixtures of cover crops, in controlling the germination of black spruce (*Picea mariana* (Mill.) BSP) and white spruce (*P. glauca* (Moench) Voss) seeds were determined. The effects of these aqueous extracts on the germination of white ash (*Fraxinus americana* L.) seeds could not be determined as the germination rate of collected white ash seeds was extremely low (see also Ontario Hydro Research Division Report No C83-62-K).

## 2.0 MATERIALS AND METHODS

### 2.1 Plant Material

Seeds of 18 cover crops and two mixtures of cover crops were obtained from Smith Seeds, Toronto, with the co-operation of Ms. S. Haxton, Forestry Projects, Hydraulic Generation and Transmission Division. The cover crops and mixtures of cover crops are listed in Table I. The seeds were planted in 30 cm pots in a 1 and 1/2 to 1 mixture of shredded topsoil (native sandy loam - obtained locally) and peat moss (Plant Products, Bramalea, Ontario), placed in the greenhouse, and watered at regular intervals. Weekly fertilizer was applied (solution of 20-20-20 (NPK) obtained from Plant Products.). Approximately three to four weeks after planting the plants were carefully removed from the soil and the soil particles adhering to the roots washed off. The shoots and roots were drained and dried at 60°C for two to three days. The dried plant material was ground to a powder in a Wiley mill, and stored in plastic bags.

Black spruce (*Picea mariana* (Mill.) B.S.P.) and white spruce (*P. glauca* (Moench) Voss) seeds were obtained from Mr. B. Graham, Forestry Resources, Ontario Ministry of Natural Resources, and stored at 5°C until required. White ash (*Fraxinus americana* L.) seeds were collected around Palgrave, Ontario, and stored at room temperature until required.

### 2.2 Preparation of Aqueous Extracts

From 5 to 10 g of ground plant material was combined with from 50 to 100 mL of deionized water and left at 25°C overnight. The water was filtered off and made up to 100 mL with deionized water. The pH of the aqueous extract was measured and a serial dilution series prepared by adding deionized water (1:1, vol:vol). Three solutions were prepared for each cover crop, ie the initial aqueous extract, a half-strength and a quarter-strength solution.

TABLE I

GERMINATION OF COVER CROPS AND
MIXTURES OF COVER CROPS GROWN IN THE GREENHOUSE

| Species of Cover Crop* | Cover Crop Number | Germination** |
|---|---|---|
| Redtop (*Agrostis gigantea* Roth.) | 1 | ++ |
| Canada bluegrass (*Poa compressa* L.) | 2 | +++ |
| Kentucky bluegrass (*P. pratensis* L.) | 3 | +++ |
| Reed canary-grass (*Phalaris arundinacea* L.) | 4 | ++ |
| Highland bentgrass (*Agrostis* sp) | 5 | +++ |
| Bentgrass (*Agrostis* sp) | 6 | ++ |
| Ladino white clover (*Trifolium repens* L.) | 7 | + |
| Creeping red fescue (*Festuca rubra* L.) | 8 | ++ |
| Tall fescue (*F. arundinacea* Schreb.) | 9 | +++ |
| Perennial ryegrass (*Lolium* perene L.) | 10 | +++ |
| Clipped bromegrass (*Bromus inermis* Leysser) | 11 | +++ |
| Champ timothy (*Phleum pratense* L.) | 12 | ++ |
| Birdsfoot trefoil (*Lotus corniculatus* L.) | 13 | + |
| Juno orchard-grass (*Dactylis glomerata* L.) | 14 | ++ |
| Climax timothy (*Phleum pratense* L.) | 15 | ++ |
| Crown-vetch (*Coronilla varia* L.) | 16 | + |
| White clover (*Trifolium repens* L.) | 17 | ++ |
| White sweetclover (*Melilotus alba* Desr.) | 18 | + |
| Mixture of clipped bromegrass (75%) and champ timothy (25%) | 19 | ++ |
| Mixture of creeping red fescue (29%) Kentucky bluegrass (29%), white clover (28%) and perennial rye grass (14%) | 20 | ++ |

* For some cover crops the species and variety were not known
** Germination rating: + = poor establishment
++ = average establishment
+++ = good establishment

All above cover crops are used in the field by Ontario Hydro.
Cover crops numbers 2, 5, 6, 16, and 18 are planted infrequently.

## 2.3 Seed Germination

In an initial screening experiment 40 black or white spruce seeds or 15 white ash seeds were placed on a filter paper in a 9 cm petri dish and 7 mL of deionized water or experimental extract added. For each extract or diluted extract tested, 40 spruce seeds (ie, in one petri dish) or 45 white ash seeds (ie, in three petri dishes) were used. The top was placed on the petri dish, which was then transferred to an incubator at 25°C in the dark for seven to eight days. The dishes were then removed and the numbers of germinated and ungerminated seeds recorded. In the initial experiment the germination rate of the white ash seeds was abysmally low (<2%) and so no results were recorded and white ash was not used in the later experiment. Poor germination of white ash seeds has been discussed previously (Ontario Hydro Research Division Report No C83-62-K). Those extracts which had shown inhibitory activity in the initial screening experiment were re-examined. In this second set of experiments 120 spruce seeds (split between three petri dishes) were used for each extract or diluted extract being examined.

## 3.0 RESULTS AND DISCUSSION

The germination performance of each of the cover crops and cover crop mixtures examined in this study is recorded in Table I. Ladino white clover, birdsfoot trefoil, crown-vetch and white sweetclover exhibited poor germination characteristics. Seedling establishment was slow and the seedlings were prone to damage during watering. This slow establishment is related to the requirement of legume species, such as the four listed above, for inoculation with various species of soil bacteria prior to seeding. These *Rhizobium* sp bacteria infect the roots of the legume, forming nodules which "fix" nitrogen from the air. The main cause of poor establishment of both crown-vetch and birdsfoot trefoil is improper inoculation with their own particular species of *Rhizobium* (Ontario Hydro Hydraulic Generation and Transmission Division Report No 0055f12). Although the four cover crop species which exhibited poor establishment at planting had not been inoculated with bacteria, they were firmly established after three to four weeks when the plants were harvested.

The grass species such as Canada bluegrass, Kentucky bluegrass, tall fescue, perennial ryegrass and clipped bromegrass all exhibited good germination characteristics and became established rapidly (Table I). Because of these rapid establishment characteristics grasses are included in various cover crop mixtures (see Table I) to ensure a stable environment for slower growing species such as legumes.

The results of the initial screening experiment, in which the effects of aqueous extracts prepared from 18 of the cover crops and cover crop mixtures on the germination of black and white spruce seeds were determined, are given in Table II. Two of the cover crops listed in Table I were not available at the time of this initial screening and were examined later. For each species three concentrations of aqueous extract were tested; the undiluted initial extract, the initial extract diluted with one volume of deionized water, and the initial extract diluted with three volumes of deionized water. The germination of white spruce seeds was inhibited by extracts from a larger number of the cover crops than the germination of black spruce seeds. One or more of the concentrations of extract from bentgrass, tall fescue, perennial ryegrass, clipped bromegrass, champ timothy, juno orchard-grass, climax timothy, white sweetclover and the mixture of clipped bromegrass and champ timothy all inhibited white spruce seed germination. In some instances, eg reed canary-grass, the germination of white spruce seeds was stimulated. Such a stimulation of tree seed germination has been observed before. Larson and Schubert (1969) reported that moderately low osmotic potentials (down to -3 atmospheres) stimulated the germination of Ponderosa pine *(Pinus ponderosa)* seeds. Rietveld (1975) found that extracts prepared by homogenization of 1 g of powdered foliar, root and litter material from both Arizona fescue *(Festuca arizonica)* and mountain muhly *(Muhlenbergia montana)* per 10 mL of distilled water all had osmotic potentials in the range 0 to -3 atmospheres. An osmotic potential of -3 atmospheres increased the germination rate of Ponderosa pine from 54% to 72% and reduced the speed of elongation of the radicle from 5.6 mm per day to 3.7 mm per day (Rietveld, 1975). In the present study the same weight of dried plant material was extracted per unit volume of water as used by Rietveld (1975) and so it is unlikely that the osmotic potential of the various cover crop extracts had a detrimental effect on germination of the spruce seeds.

The germination of black spruce seeds was less suceptible to inhibition by the cover crop extracts tested than white spruce. The initial extracts (0.1 g/mL strength) of crown-vetch and white sweetclover inhibited germination of black spruce seeds substantially (Table II).

The inhibitory effects on the germination of spruce seeds described above could be the result of a very acidic or basic extract. The pH of each initial extract is given in Table II. The values observed varied from 4.9 with Ladino white clover to 5.9 for both Canada bluegrass and Kentucky bluegrass. Rietveld (1975) reported that aqueous extracts from foliage, roots and leaf litter of Arizona fescue and mountain muhly had pH values in the range 4.6 to 6.1 and this author considered that the low

## TABLE II

### EFFECT OF AQUEOUS EXTRACTS PREPARED FROM VARIOUS COVER CROPS ON THE GERMINATION OF BLACK AND WHITE SPRUCE SEEDS - INITIAL EXPERIMENT

| Strength of Aqueous Extract Tested* (g/mL) | White Spruce | | | Black Spruce | | |
|---|---|---|---|---|---|---|
| | 0.025 | 0.050 | 0.100 | 0.025 | 0.050 | 0.100 |
| | Percent Germination | | | | | |
| Species of Cover Crop Tested | | | | | | |
| ( 1) Redtop [5.4] | 28 | 25 | 23 | 95 | 90 | 85 |
| ( 2) Canada bluegrass [5.9]** | - | - | - | - | - | - |
| ( 3) Kentucky bluegrass [5.9]** | - | - | - | - | - | - |
| ( 4) Reed canary-grass [5.4] | 38 | 38 | 25 | 93 | 93 | 91 |
| ( 5) Highland bentgrass [5.5] | 18 | 26 | 25 | 93 | 90 | 83 |
| ( 6) Bentgrass [5.5] | 26 | 20 | 13 | 88 | 97 | 81 |
| ( 7) Ladino white clover [4.9] | 33 | 23 | 20 | 91 | 93 | 93 |
| ( 8) Creeping red fescue [5.5] | 31 | 30 | 25 | 95 | 95 | 90 |
| ( 9) Tall fescue [5.4] | 3 | 8 | 8 | 93 | 90 | 83 |
| (10) Perennial ryegrass [5.5] | 18 | 10 | 25 | 93 | 83 | 93 |
| (11) Clipped bromegrass [5.3] | 17 | 13 | 10 | 85 | 78 | 85 |
| (12) Champ timothy [5.3] | 18 | 28 | 5 | 85 | 77 | 80 |
| (13) Birdsfoot trefoil [5.4] | 30 | 28 | 39 | 98 | 88 | 85 |
| (14) Juno orchard-grass [5.5] | 17 | 5 | 14 | 88 | 75 | 78 |
| (15) Climax timothy [5.4] | 18 | 20 | 10 | 93 | 83 | 74 |
| (16) Crown-vetch [5.2] | 32 | 23 | 17 | 95 | 90 | 59 |
| (17) White clover [5.2] | 23 | 25 | 26 | 95 | 95 | 71 |
| (18) White sweetclover [5.4] | 7 | 5 | 5 | 95 | 90 | 66 |
| (19 Mixture of clipped bromegrass and champ timothy [5.6] | 15 | 13 | 18 | 93 | 98 | 90 |
| (20) Mixture of creeping red fescue Kentucky bluegrass white clover and perennial rye grass [5.5] | 18 | 30 | 35 | 90 | 98 | 80 |
| Water control | 25 | | | 92 | | |

* Initial aqueous extracts were prepared by extracting 8 g plant material with 80 mL deionized water overnight. Strength of this initial extract will be 0.1 g/mL of water, and subsequent dilutions 0.05 g/mL and 0.025 g/mL. The values in square brackets are the pH of the initial aqueous extracts.

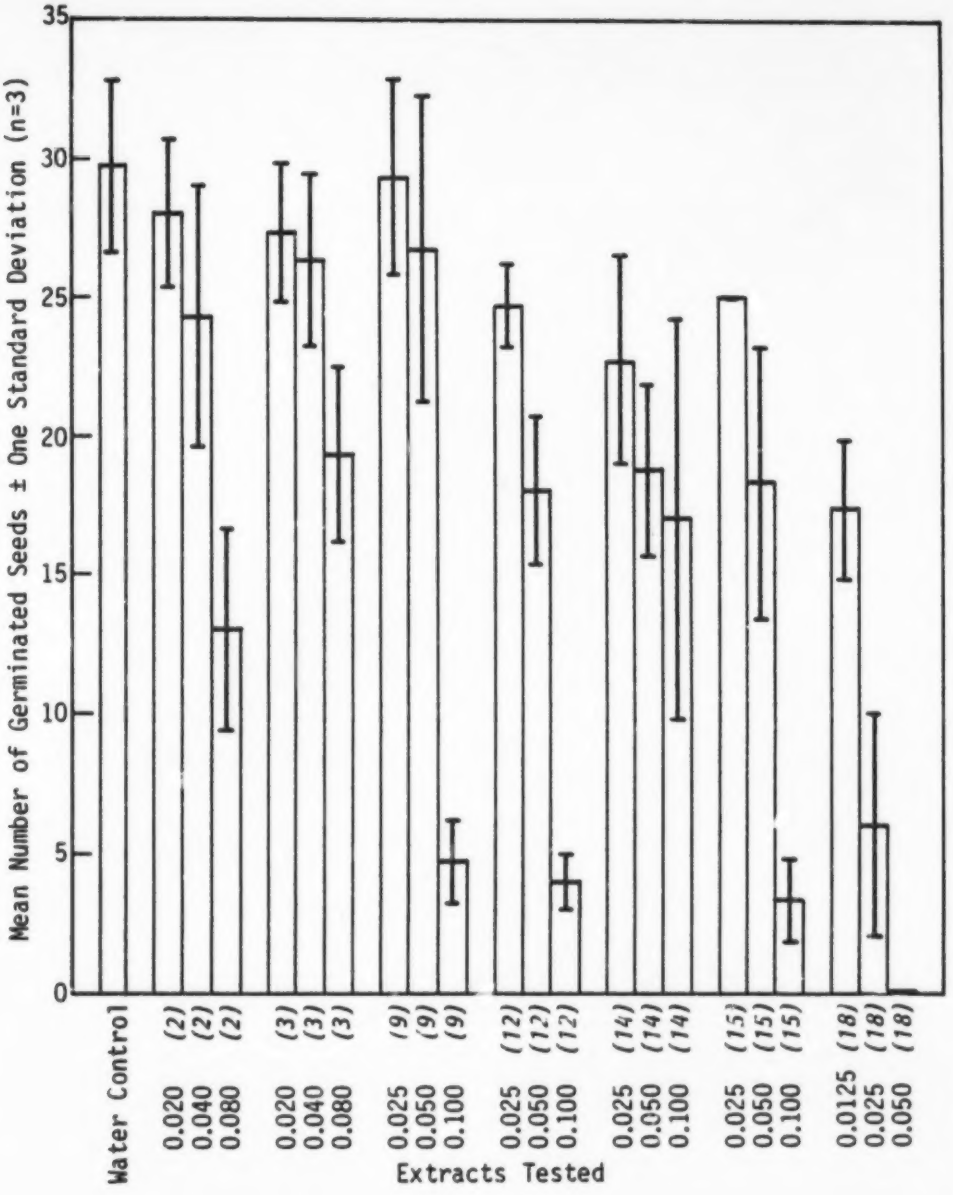
** Obtained with extracts prepared later

\- Cover crops 2 and 3 were not available for evaluation until later (see Figure 1).

pH values observed did not significantly affect the germination of ponderosa pine seeds. Brown (1967) reported earlier that the pH of the extracts from 56 plants commonly associated with jack pine *(Pinus banksiana)* was not a factor in the inhibitory or non-inhibitory effect of the extracts on the germination of jack pine seeds. Rietveld (1975) reported a pH value of 5.5 for his distilled water control, whilst the deionized water routinely used in the control in the present study had a pH value of approximately 5.8, there being a day to day fluctuation in the pH values obtained as a result of changes in the efficiency of the deionization apparatus. The lack of effect of low pH on the germination of spruce seeds is exemplified by the fact that the extract from Ladino white clover had a pH of 4.9 yet had no inhibitory effect on the germination of black or white spruce seeds (Table II).

In an effort to discover more about the relationship between extract concentration and inhibition of seed germination several of the cover crop extracts which had shown inhibitory effects in the initial screening experiment were then examined again using a larger number of seeds, 120 rather than 40, split between three petri dishes rather than just one. In the initial screening experiment the most dilute extract of tall fescue had inhibited the germination of white spruce seeds more than the undiluted or half-strength extracts tested (Table II). Extracts from Canada bluegrass and Kentucky bluegrass were also tested in these later experiments, as the plant material had become available. Fresh extracts were prepared for each cover crop and the results of these experiments with white spruce are shown in Figure 1. The highest concentrations of extract from Canada bluegrass, Kentucky bluegrass, and tall fescue inhibited the germination of the white spruce seeds, whilst the more dilute extracts did not. With an increase in the concentration of the extracts from champ timothy, climax timothy and white sweet clover there was a concomitant increase in the inhibition of white spruce seed germination. The undiluted extract of white sweetclover was particularly effective, with none of the 120 seeds germinating. This undiluted extract, prepared by extracting 50 g of dried plant material with 100 mL deionized water, was half the strength of the initial extract tested in Table II. Insufficient plant material was available to produce an initial extract of the same concentration as used in the initial experiment.

In this second set of experiments the germination rate of white spruce seeds in the control experiment was higher than in the initial screening experiment outlined in Table II, ie 90 out of 120 (75%) as opposed to 10 out of 40 (25%). Although there is no obvious explanation for this discrepancy, these values would appear to be correct for each particular set of experiments,




*Numbers in Brackets refer to Species Number:*

*(2) Canada Bluegrass*
*(3) Kentucky Bluegrass*
*(9) Tall Fescue*
*(12) Champ Timothy*
*(14) Juno Orchard-Grass*
*(15) Climax Timothy*
*(18) White Sweetclover*

*Figures to left of Brackets refer to Strength of Aqueous Extract, in g dry weight of plant material extracted per ml of water.*

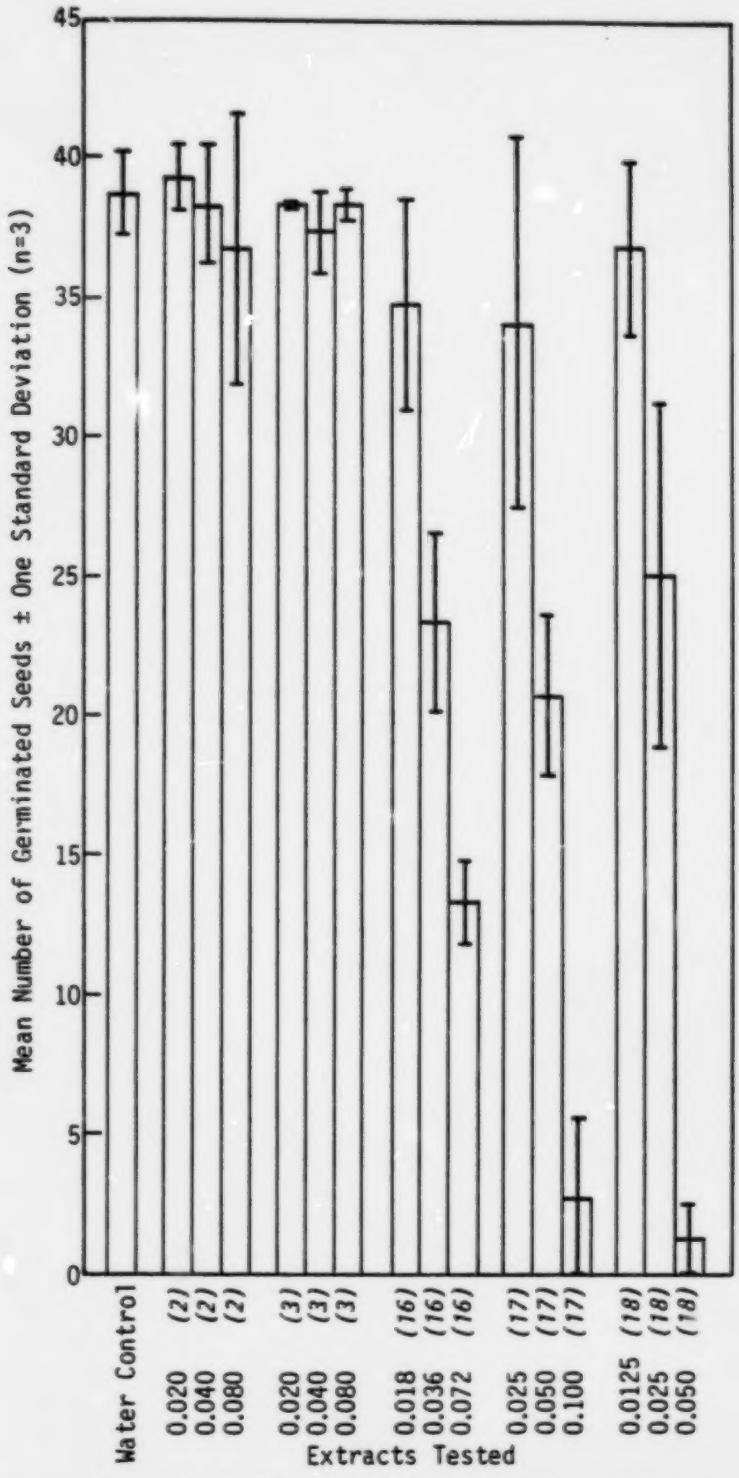
**FIGURE 1**

**EFFECT OF AQUEOUS EXTRACTS PREPARED FROM SEVERAL COVER CROPS ON THE GERMINATION OF WHITE SPRUCE SEEDS**

since in experiments where extracts did not cause an inhibition of germination, the germination rates observed were similar to the control rates. This explanation holds particularly well for the second set of experiments outlined in Figure 1, eg compare the most dilute extract of cover crop number 9 with the water control.

When several of the cover crops which had shown inhibitory activity to germination of black spruce seeds in the initial screening were examined in more detail, the extracts from the legumes white sweetclover, white clover, and crown-vetch all inhibited germination in a concentration-dependent manner (Figure 2). Neither Canada bluegrass not Kentucky bluegrass had any effect on the germination of the black spruce seeds.

The data obtained in this second set of experiments were then subjected to a one way analysis of variance to see if there were statistically significant differences between the cover crop extracts in terms of effects on spruce seed germination. The various extracts and diluted extracts described in Figures 1 and 2 were divided into three classes of extract, high, medium and low strength, on the basis of dry weight of plant material extracted per millilitre of water. Ranges were chosen for each class because not all the initial aqueous extracts had been prepared from the same dry weight of plant material per unit volume of water. These discrepancies were maintained because each initial aqueous extract was diluted to produce a half-strength and quarter-strength extract. The class ranges are given in Table III. For the three classes of extract tested with both white and black spruce the F-ratio values obtained were all significant at the 5% level (data not shown) indicating that within each class one or more of the cover crop extracts had a statistically significant effect on seed germination. Multiple range tests (SNK) were conducted with these data (see Table III). As the strength of the extracts tested with both white and black spruce was reduced from high to low, the number of cover crops which significantly affected germination was reduced. Even at low strength, the extract from white sweet-clover inhibited the germination of both white and black spruce whilst no other low strength extracts did. Extracts from the legumes crown-vetch and white clover were not as inhibitory as that from white sweetclover when tested with black spruce seeds. Extracts from a group of three grasses, climax timothy, juno orchard-grass and champ timothy, were inhibitory to the germination of white spruce seeds although they were not as effective as the white sweetclover extracts. From the results obtained in this study it appears that as a plant group the legumes may be more effective than grasses in inhibiting the germination of spruce seeds.




*Numbers in Brackets refer to Species Number:*
*(2) Canada Bluegrass (17) White Clover*
*(3) Kentucky Bluegrass (18) White Sweetclover*
*(16) Crown-vetch*
*Figures to left of brackets refer to Strength of Aqueous Extract, in g dry weight of plant material extracted per ml of water.*

**FIGURE 2**
**EFFECT OF AQUEOUS EXTRACTS PREPARED FROM SEVERAL COVER CROPS ON THE GERMINATION OF BLACK SPRUCE SEEDS**

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## TABLE III

MULTIPLE RANGE TESTS COMPARING THE GERMINATION OF WHITE AND BLACK SPRUCE SEEDS AND THE VARIOUS EXTRACTS IN WHICH THE SEEDS WERE GERMINATED FOR THREE CONCENTRATION CLASSES OF EACH EXTRACT*

| Seeds Germinated | Strength of Extract (Class Range) | Cover Crop Extracts Tested |
|---|---|---|
| White Spruce | High (0.080 to 0.100 g/mL) | - 15 12 9 14 3 2 Control |
| White Spruce | Medium (0.040 to 0.050 g/mL) | 18 15 14 12 9 3 2 Control |
| White Spruce | Low (0.020 to 0.025 g/mL) | 18 15 14 12 9 3 2 Control |
| Black Spruce | High (0.072 to 0.100 g/mL) | - 17 16 3 2 Control |
| Black Spruce | Medium (0.036 to 0.050 g/mL) | 18 17 16 3 2 Control |
| Black Spruce | Low (0.018 to 0.025 g/mL) | 18 17 16 3 2 Control |

* The multiple range tests described above were calculated from data presented in histogram form in Figures 1 and 2. The various strengths of extract cited in the figures on the basis of g dry weight of plant material extracted per mL of water (g/mL) were grouped into three classes of extract, high, medium and low, for both white and black spruce germination tests. The range for each class is quoted above in brackets. Extracts which produced germination rates which did not differ significantly are underlined by the same bar, the significance level being 5%. Extracts which produced germination rates which do differ significantly are underlined by different bars.

Key to cover crops: (2) Canada bluegrass, (3) Kentucky bluegrass, (9) tall fescue, (12) champ timothy, (14) juno orchard-grass, (15) climax timothy, (16) crown-vetch, (17) white clover, (18) white sweetclover: no high strength extract was tested.

The suppressive effects of extracts of legumes such as sweetclover on the germination and seedling growth of various forages, weeds and cereals have been described before (see Lawrence and Kilcher, 1962) and it has been suggested that the coumarins, phenylpropanes which are produced by legumes amongst others (Whittaker and Feeny, 1971), are responsible for the inhibition of plant growth (see Lawrence and Kilcher, 1962). Coumarins have been reported to inhibit gibberellin-induced growth in dwarf-pea seedlings (Corcoran et al, 1972; Green and Corcoran, 1975).

The precise location within the plant of the active agents present in these aqueous extracts which inhibited black and/or white spruce seed germination in the present study remains to be identified. It would be useful to know if such agents are present in either root exudates and/or leaf litter material produced by the plant in question. The effectiveness of those cover crops known to contain germination inhibitors in influencing woody plant development in the field should be determined.

## 4.0 CONCLUSIONS

1. Aqueous extracts prepared from dried shoot and root material of the cover crops Canada bluegrass, Kentucky bluegrass, tall fescue, champ timothy, climax timothy and white sweetclover inhibited the germination of white spruce seeds. The extracts from white sweetclover, a legume, were the most inhibitory of those tested. There was an obvious direct relationship between the concentration of white sweetclover extract and the level of inhibition of white spruce seed germination.

2. All those cover crop extracts which inhibited the germination of white spruce seeds did not inhibit the germination of black spruce seeds. However, extracts of the legumes crown-vetch, white clover and white sweetclover were particularly effective in inhibiting black spruce seed germination.

3. Although aqueous extracts prepared from some cover crops, particularly some legumes, are effective in inhibiting the germination of woody plant seeds such as black and white spruce, it remains to be determined if such cover crops inhibit the growth of these particular woody plants or the germination and growth of other woody plants in a field situation.

Approved:

D. Harrison
Manager
Chemical Research Dept

GPA:lg

Submitted:

G.P. Arron
Biologist
Biological Research Section

## BIBLIOGRAPHY


Brown, R.T. (1967) Influence of naturally occurring compounds on germination and growth of jack pine. Ecology 48, 542-546.

Corcoran, M.R., Geissman, T.A., Phinney B.O. (1972) Tannins as gibberellin antagonists. Plant Physiol. 49, 323-330.

Green, F.B., Corcoran, M.R. (1975) Inhibitory action of five tannins on growth induction by several gibberellins. Plant Physiol. 56, 801-806.

Larson, M.M., Schubert, G.H. (1969) Root competition between Ponderosa pine seedlings and grass. USDA Forest Service Research Paper RM-54, 12 p.

Lawrence, T., Kilcher, M.R. (1962) The effect of fourteen root extracts upon germination and seedling length of fifteen plant species. Can. J. Plant Sci. 42, 308-313.

Ontario Hydro Hydraulic Generation and Transmission Division Report No 0055f12. A guide to seeding rights-of-way cover crops. Anonymous.

Ontario Hydro Research Division Report No 82-461-K. Allelopathy - the effect of one species of plant or microorganism on the growth and development of another: a literature review. G.P. Arron.

Ontario Hydro Research Division Report No C83-62-K. Biological control - development of assay. G.P. Arron.

Rietveld, W.J. (1975) Phytotoxic grass residues reduce germination and initial root growth of Ponderosa pine. USDA Forest Service Research Paper RM-153, 15 p.

Whittaker, R.H., Feeny, P.O. (1971) Alleochemics, chemical interactions between species. Science 171, 757-770.